

Dr. Gresswell's Report to the Local Government Board on the
Prevalence of Enteric Fever in the Registration Sub-District
of Hebden Bridge.

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THE registration sub-district of Hebden Bridge is situate in Yorkshire, its chief town, Hebden Bridge, being 8 miles W.N.W. from Halifax. It comprises the townships of Wadsworth, Heptonstall, Erringden, and the lowest third of Stansfield, and it covers an area of 18,759 acres. It is divided into the Hebden Bridge urban and Todmorden rural districts, and its population at the census of 1881 was 12,314.

It is a portion of the watershed of the River Calder near its source. It is very hilly, and presents extensive tracts of peat-moorland. The geologic formation is Millstone Grit, covered by a small depth of soil.

Enteric fever has been endemic in this part for many years, at times in a sporadic, at times in an epidemic form. It took an epidemic form in the autumn of 1884, and this inquiry (in February 1885) was directed towards the determination of the cause of its continued prevalence, and of its occasional exacerbations.

The urban district will be especially dealt with, such reference only as seems necessary being made to the rural district.

A description of the local sanitary conditions may form a fitting prelude to an attempt at the explanation of the prevalence of the fever.

The urban district of Hebden Bridge has an area of 357 acres, and takes in part of the townships of Heptonstall, Wadsworth, Erringden, and Stansfield. The inhabitants in 1881 numbered 5,008. They are concentrated mainly in the town called Hebden Bridge; a few are at Mythilmroyd, about a mile to the east of the latter town.

Hebden Bridge is a small manufacturing town; it lies in a deep valley on the banks of the Calder at its junction with the River Hebden. The slopes of the valley are in parts rocky, in parts wooded; in greater part they are pasture and moor land. The Calder flows almost due eastward at the bottom of the valley; it is joined on the north by the Hebden, and is bounded on either side by a strip (wider on the north) of clay, sand, and gravel soil.

The houses of Hebden Bridge are almost confined to the north side of the Calder; they lie at the bottom of the valley, and in terraces on the lower slopes. The Hebden joining the Calder on the north roughly divides the town into eastern and western halves. Most of the inhabitants work in factories. The staple industries are cotton-spinning, weaving, fustian-manufacturing, dyeing, and wholesale clothes-making. The population of the district increased from 3,666 in 1871 to 5,008 in 1881. This rapid increase is attributable chiefly to the great demand for fustian and ready-made clothes, which are sent all over the country, and now are being sent to the colonies.

This district receives a large rainfall; $45\frac{1}{2}$ inches of rain fell at Todmorden (in the same valley as and four miles to the west of Hebden Bridge) last year, and this, moreover, when the rainfall over nearly the whole of Great Britain was decidedly below the average. In rainy seasons the river overflows its banks, flooding the lower parts of Hebden Bridge. It has been known to flood them to a depth of even two or three feet in the main streets.

The *habitations* are, most of them, labourers' cottages. Building land is costly, and the demand for cottages is largely in excess of the supply; as a consequence the cottages are cramped for space, both outside and in. Cottages on the flat are built, many of them, back-to-back; many even of those which have been recently built. Most of the rest are four-storey structures; the two lower storeys set into the hillside face one street and are occupied as one tenement, the two upper face the street above and are occupied either as one tenement or as two, front and back. Many sanitary defects attend upon these modes of building. The back-to-back cottages have no through ventilation, for though the making of ventilating flues in the party-wall is enjoined in the twelfth of the local byelaws* (passed in 1867), even this

* Byelaw No. 12 runs thus: "That no building shall be erected in any square, court, alley, yard, or passage, whether a thoroughfare or not, nearer than ten yards of the building or boundary on the opposite side of such square, court, alley, yard, or passage, and that in the case of houses built back-to-back provision must be made for a thorough draught by ventilating flues in the party-walls——"

attempt at through ventilation in the cottages visited, whether old or new, was effectually prevented by the plastering and papering of the party-wall. Again, the lower tenements of the four-storey structures are not adequately protected from the wet of the hill above; their back wall is built *close up* to the excavated side of the hill, and there is no provision made either for drainage between the back wall and the hillside, or for through ventilation. They are therefore necessarily damp in almost all cases. Many similar structures are built in three storeys, the lower one (perhaps only one room) being occupied as one tenement by as many as four to six persons. The lower storeys are, moreover, sadly deficient in light, especially when, as frequently occurs, the opposite side of the street is built upon, and the street itself is narrow. Most are provided with cellars, the floors of which, in the case of cottages on the flat, are but slightly above the level of the sewer into which they drain. (The main sewers of the east part of the town are old square stone culverts, and when they run even moderately full some of the cellars which drain into them are inundated.) There is no basement adequate for protection from ground air and ground water. The new cottages are but little better off in these respects than the old ones.

The *privy accommodation* for old cottages is afforded in several cases by old midden privies, in a few instances by water-closets, and more recently by pail-closets; that for new cottages is afforded by either water-closets or pail-closets. There are said to be in all about 308 pail-closets, 126 water-closets, and 41 midden privies. The water-closets are but rarely ventilated and very rarely lighted. The soil-pipe is scarcely ever ventilated, and one trap (the one immediately under the pan, and that very frequently a D trap) alone intervenes between the closet and the sewer. This holds also of the better houses. Most of the old water-closets are flushed by water laid on from cisterns supplied by springs in the hill above; this supply generally runs short in summer, and the closets then are not properly flushed. The new water-closets are supplied by the Local Board works, which afford a constant supply at high pressure. A considerable number of old midden privies still remains, even in the centre of Hebden Bridge. Many are in most dangerous proximity to dwellings, and all which were examined were open and non-cemented, affording every facility for the pollution of near water-courses. The area of soil liable to pollution from old midden privies is great in this district, for the soil is of small depth, and it overlies dense millstone grit.

House refuse is thrown into midden ashpits or into separate ashpits, almost all of which are open. Where there is a pail-closet a separate box is used for ashes.

Sewerage.—There are many independent sewers. Those of a large part of the east half of the town form one connected system; most of them are 12-inch glazed earthenware socket-pipes, all of which discharge into two old stone square culverts, which after a lengthy course, with a fall of three-quarters of an inch per yard, open together into the Calder at the east end of the town. Those of the west half are similar earthenware pipes; they form several independent systems and discharge separately into the Calder. An efficient means of flushing the culverts has been devised recently, since the outbreak, and it is kept in continuous operation. Almost all of the rain-pipes are in direct communication with the sewers, scarcely any being disconnected or even trapped. In some houses now building in the main street leaden rain-pipes, jointed apparently with red-lead, run down inside the house in part imbedded in mortar, in part exposed, and enter into direct communication with the sewer. Very many of the sink-pipes have direct communication with the sewer, though many have recently been disconnected; many discharge over a trap *in the floor of the cellar*. Several bell traps were seen.

The rain-pipes, almost all of which are in direct communication with the sewers, are the chief sewer ventilators. It should be mentioned here that a few houses have flap-windows in the roof.

The sewers of Todmorden also discharge into the Calder at a point about three miles up the river from Hebden Bridge.

The river is thus greatly polluted, and when it is low, as it is in summer, the stench arising from it is much complained of.

Scavenging is done only in part by the Local Board, and especially in connexion with the pail-system, which is being rapidly extended. An iron cart is driven round at night twice a week; the tubs and pails are there and then emptied, and without having undergone any cleansing or disinfecting process are replaced. The contents are taken to a field about a mile away, where they are mixed with "shoddy" (a refuse from the cotton mills), and then are carted away on to the land. A charge of twopence is made for each tub that is emptied. The Local Board also remove ashes once a week in a separate cart, charging one penny per tub.



There can be no doubt that these charges tend to encourage accumulations of house refuse; some of the poor will not pay the charge until their pails are brimful, and it may be overflowing, so that the pail and the closet become offensive. Some again discharge the contents of their own pails and ash-boxes directly into the river (in preference to paying the Local Board), and so cause nuisance. Nuisance from this cause has decreased since the charge was lowered from threepence to twopence a short time ago. The abolition of the charge would doubtless be of great sanitary advantage.

There are two main *water supplies*. One is from the Local Board waterworks. The collecting ground for this water is moorland of large extent, at Widdup, about six miles away, and at a very considerable elevation (some 1,000 feet) above Hebden Bridge; it is far removed from ordinary sources of pollution. The water is brownish, owing to the peaty character of the land from which it is collected. It is laid on in nearly every street, and every facility is given to owners of property to obtain it.* The other supply is from springs, which issue in great numbers from the hillsides. In some instances this spring water is used at its very source; very exceptionally it is carried some little distance in pipes; in most instances it is allowed to flow some distance, open to all conceivable modes of pollution, before it is used. There is, indeed, generally a most careless disregard of the liability to pollution of these water-courses from open, unpaved, or at least non-cemented privy-pits, slop streamlets, manure piled in heaps or scattered over the land and into the very water-courses themselves, and from leaking stone sewers. It will be necessary to describe some of these supplies in detail.

1. *The Bridge Lane supply*.—This is said to come from three springs. It flows from these down hill in labyrinthine courses under the houses which flank the street called Bridge Lane, and it is tapped by almost every householder on the way. At one point the issuing water is said frequently to have the appearance of slop-water, and at another to frequently “stink like sewage.” An old midden privy, indeed, lies immediately above the course of the water, and in the lane itself there are two old stone sewers for slops and surface water. Most of the inhabitants, however, of this cramped and overcrowded part of the town use this water for drinking.

2. *The Royd Terrace supply*.—This is very similarly circumstanced. It flows from the hills above, and is tapped on its way for certain domestic uses, while immediately over its course there is a large open and old-fashioned midden privy.

3. *The Foster Mill Lane supply*.—This also flows from springs in the hill above, and is used by most of the inhabitants of the lane. It collects in a large stone cistern. Old midden privies are within 50 yards above the cistern, and slop streamlets flow over the site of it.

4. *The Birchcliffe supply*.—This water collects in several large stone cisterns situate at various heights on the north-east slope of the valley. It is supplied by many springs in the hill above. Much of it comes from three springs on the Birchcliffe Farm. These are within a hundred paces of one another. The water issuing from them flows *along* the hillside in three open parallel narrow channels over meadow land for a distance of some 200 to 350 yards, and then it sinks into the soil. The water of the channels which are *lowest* on the hillside then passes in underground courses for some 50 yards, and enters a large cistern called the White Lion cistern. The water of the higher channel is supposed to pass underground to some of the other cisterns, which, six in number, are placed in near proximity to one another. The latter, however, are doubtless also fed by other springs whose position is not known. That one of them receives water from the Birchcliffe land is indicated by the observation, made by many who use it, to the effect that when gas-lime is put on the Birchcliffe land the water is tainted with its odour. The Birchcliffe water is open to pollution on every side.† The land over which the above-mentioned channels run is part of the slope of the valley; it is thickly manured (with human as well as animal excreta) in autumn; on the hillside, *above* and within a short distance of the springs and channels, there were, at the time of my visit, two large privy-pits, a small privy, and a large manure heap, the tracks of leakage from some of which were very plainly visible down to the uppermost channel;

* The Local Board supply water to the factories *by meter*; this is accordingly economized, and water from local and dangerous sources is frequently supplied to the factory-hands.

† Six samples of the Birchcliffe water were taken in January 1885, one from each of the three springs, and one from each of three of the cisterns. They were pronounced by Mr. W. G. Wood, F.I.C., F.C.S., to be “very pure”; he added, “the waters may be used safely for drinking purposes.” He reported that the cistern waters had on an average half a grain more solid matter per gallon, 0·33 grain more of organic and volatile matter, 0·17 grain more of organic matter, rather less free ammonia, and rather more albumenoid ammonia than the average of the spring waters.

slop streamlets also flow down from the houses above, and a still used cemetery whose natural drainage is towards the channels is some 150 yards above them. It may be noted here that the water of the lowest channels is least open to pollution, *i.e.*, the water which enters the White Lion cistern. Again, immediately above one of the cisterns there is a large open midden privy; immediately above another there is a large non-cemented ashpit, which, until quite recently, received fæces and house refuse from one row of houses, and which still receives ashes, and at times fæces.

The *milk supply* is furnished by some 20 or more dairymen, who are not registered. One man may have from 4 to 20 cows. Almost all the cow-houses visited (10) were very dark, low in the roof (about six feet), and badly ventilated. The milk-pails are cleansed with scalding water, but in many cases they are rinsed afterwards with cold water.

The *slaughter-houses* are registered and kept cleanly.

The only *notification of infectious disease* is a weekly return of *deaths* from infectious diseases made by the registrar.

There is no public means of *isolating* infectious cases, none even in the workhouse; and there is no disinfecting apparatus. Small-pox patients have, however, for many years past been generally sent at once to Halifax, eight miles away; this has been done four or five times within the last 10 years; as matter of fact, small-pox has never spread, and no death since 1878 has been recorded from this disease for the whole sub-district. On the other hand, there have been, on an average, four or five deaths from scarlet fever per year since 1878.

The importance of *prompt notification* and *ready means of isolation* in Hebden Bridge can scarcely be overrated. In the first place most of the cottages are overcrowded, and infectious diseases generally spread when introduced into a family. This is seen in the case even of enteric fever. At the date of my inspection one small cottage having 1,500 cubic feet of air-space, with three small bedrooms, has seven (it has at times nine) occupants, while one bedroom, the largest, is occupied by a patient suffering from typhoid fever. Again, while one member of a family is ill, another is working, it may be, in a fustian or ready-made clothes factory; those, moreover, who have suffered from infectious disease return to work in these factories wearing clothes which have not been disinfected; scarlet fever, we should suppose, may thus be scattered broadcast over the country, and even exported.

No epizootic disease has fallen during the last year within the cognizance of the veterinary surgeons practising in the sub-district, and no disease among the cows of the dairy farms visited was discovered.

Vital statistics of the urban district for the last seven years are set out in Table A.

TABLE A.

VITAL STATISTICS OF THE HEBDEN BRIDGE URBAN DISTRICT.

The population at census in 1871 numbered 4,500, and in 1881 it numbered 5,008.

YEAR.	Births.		Deaths.		Deaths under one year.		Deaths from													Zymotic rate per 1,000 per annum.
	Number.	Rate per 1,000 per annum.	Number.	Rate per 1,000 per annum.	Number.	Rate per 1,000 Births.	Small-pox	Measles.	Scarlet Fever.	Diphtheria.	Croup.	Whooping Cough.	Fever.	Diarrhoea, Dysentery, and Cholera.	Rheumatic Fever.	Ague.	Phthisis.	Bronchitis, Pneumonia, and Pleurisy.	Heart Disease.	
1878	140	29	100	20·7	20	142·8	—	—	11	1	1	—	—	1	1	—	6	23	2	2·9
1879	153	30	116	22·8	29	189·5	—	—	10	—	1	4	2	3	2	—	8	21	3	3·9
1880	145	28·4	108	21·1	26	179·3	—	2	4	—	—	—	2	3	—	—	9	18	3	2·1
1881	151	30·2	91	18·2	26	172·1	—	—	—	—	3	2	1	—	—	—	7	20	2	1·2
1882	190	38	118	23·6	34	178·9	—	9	2	—	2	5	3	2	—	—	8	14	4	4·5
1883	140	26·4	99	18·6	20	142·8	—	1	2	—	—	2	—	1	—	—	15	17	5	1·1
1884	166	30·9	103	19·2	21	126·5	—	3	3	—	—	3	10	2	—	—	8	14	10	3·0
Average of 7 years	155	30·4	105	20·6	25·1	161·7	—	2·1	4·5	·14	1	2·2	2·5	1·7	·4	—	8·7	18·1	4·1	2·8
Average rate per 1,000 population per annum during the last 7 years	—	—	—	—	—	—	—	·4	·9	·03	·2	·7	·5	·34	·08	—	1·7	3·6	·8	—

The high rate of infantile mortality is ascribed by Dr. Lawson, the Medical Officer of Health, to lack of mothers' milk, the mothers being themselves engaged in factories; he also condemns the entering of babes in insurance societies.

The great rainfall and dampness of the soil are doubtless factors in the high rate of mortality from diseases of the respiratory organs.

Enteric Fever.—Deaths from "fever" in the registration sub-district of Hebden Bridge are recorded for each of the last 15 years, the year 1881 alone being excepted. They are registered in Table B., from which it may be seen that one or more occurred in each of the fourth quarters (except that of 1881), in most of the first quarters, in about a half of the third quarters, and a fourth of the second quarters.

TABLE B.

DEATHS from "FEVER" in the REGISTRATION SUB-DISTRICT of HEBDEN BRIDGE for each quarter since 1870.

The population in 1861 was 10,826, in 1871 it was 11,193, and in 1881 it was 12,314.

—	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.
1st quarter -	3	2	1	1	—	2	1	—	—	2	2	—	3	1	
2nd quarter -	—	—	—	1	2	—	—	—	1	—	3	—	—	—	—
3rd quarter -	2	3	2	—	—	1	—	1	—	2	—	—	1	—	3
4th quarter -	3	2	7	2	4	1	2	3	1	2	1	—	1	2	11
Total -	8	7	10	4	6	4	3	4	2	6	6	—	5	3	14

Those deaths from "fever" which occurred since 1878 included no case of typhus, and they were distributed between the rural and urban districts as shown in Tables C. and D.

TABLE C.

DEATHS from "FEVER" in the TODMORDEN RURAL DISTRICT, the population of which in 1881 was 7,306.

—	1878.	1879.	1880.	1881.	1882.	1883.	1884.	Totals.
1st quarter -	—	—	1	—	1	1	—	3
2nd quarter -	1	—	2	—	—	—	—	3
3rd quarter -	—	2	—	—	—	—	—	2
4th quarter -	1	1	—	—	—	1	4	7

TABLE D.

DEATHS from "FEVER" in the HEBDEN BRIDGE URBAN DISTRICT, the population of which in 1881 was 5,008.

—	1878.	1879.	1880.	1881.	1882.	1883.	1884.	Totals.
1st quarter -	—	1	—	—	2	—	—	3
2nd quarter -	—	—	1	—	—	—	—	1
3rd quarter -	—	—	—	—	—	—	3	3
4th quarter -	—	1	1	—	1	—	7	10

In 1883 there was no death from fever in the urban district, and there were only two in the rural. In the first half of 1884 there was none, but in the second half there were 14 in the two districts, *i.e.*, not far short of half of the total deaths from fever since the beginning of 1878.

Fever, then, has continually prevailed here more or less, but prior to 1884 there had been no outburst for 12 years approaching in deadliness to that of the second half of 1884, during which time four deaths occurred in the rural and 10 in the urban district.

While seeking the cause of the continued prevalence of fever, the facts above mentioned concerning the sanitation of the place present themselves in all their fever-abetting reality. Overcrowding, defective ventilation, habitations drawing sewer air through sink-pipes, through soil-pipes, and from filth-sodden soil, water open to pollution on every side; these afford conditions favourable enough for the prevalence of the disease.

The fever has frequently been attributed to polluted water. Dr. S. T. Steele, while Medical Officer of Health, repeatedly drew attention to the pollution of the water, and to the facility with which typhoid fever could be traced up the hills to farm above farm, the water supply of the lower farm being polluted on the farm above. He condemned the *Bridge Lane water* as being the cause of typhoid fever, of which in 1875 he wrote saying that it had been endemic in Bridge Lane for the previous 10 years. He likewise ascribed the large number of typhoid cases which occurred some 12 years ago in *Foster Mill Lane* to pollution of the water. He also condemned the *Birchcliffe water*. Dr. Lawson, who succeeded Dr. Steele in 1878, and who still holds the office, has repeatedly spoken to the same effect.

Let us now turn to the outbreak of last year. That it was one of enteric fever is evidenced by the record of rose spots, diarrhœa, intestinal hæmorrhage, and relapse. The first two cases occurred in March and July respectively, in a short isolated row of cottages at the west end of the town, in which cases of typhoid fever are reported to have occurred in the previous year. They were attributed to the drinking of a local spring water polluted by leakage from a privy used by the occupants of these cottages. Then, on July 15th, a woman died, it is said, of typhoid fever near to the centre of the town. She had shivering, lumbar pain, headache, and vomiting, but she continued to keep about for a week or so; she then took to bed and died on the fifth day afterwards of "asthenia." Her stools were not disinfected, and her husband says that he had not the slightest idea that she was suffering from fever. The sink-pipe communicated directly with the sewer. The water used was that of the Local Board. The milk supply is not suspected. It is probable that she did not communicate typhoid fever to the next cases, because the next two cases, which occurred simultaneously in the first week of August (a fortnight after this woman's death), were living in two different though contiguous streets at some distance from her house, and they had had no relations with her.

Ten tenements were affected between August 1st and October 15th, in one small portion of the town. Later four tenements in other parts of the town were affected, and still later six tenements, all within the small portion of the town in which the above ten had already been affected. It will be necessary to examine carefully the cases in the tenements which were first affected. I have said that they were not probably due to infection from the woman whose case has been described; they could not, moreover, be traced to the March and July cases. They cannot be ascribed to the milk because (1) the first two tenements which were affected almost simultaneously, had different milk supplies; (2) the third had yet another milk supply; (3) the four next, all of which were affected almost simultaneously in two different streets, had four different milk supplies; (4) each of the milkmen who supplied the above, supplied also very many other tenements which were not affected. They would possibly be ascribed by some to the insanitary state of the dwellings in which they occurred. Thus:—of the first two simultaneous cases, one had suffered from "stinks" from his water-closet which had not been properly flushed owing to scarcity of water, and the other had been boiling tripe, and had allowed his cellar to get into such a filthy and stinking condition that the next tenant "could not stand the smell." The third case had his house-drain blocked so that the main culvert sewer had to be opened up, and he had suffered from stinks in the house. The fourth case occurred at a distance, and is not apparently explicable on the ground of uncleanness in the

house. The fifth case had complained of stinks from an untrapped opening in a drain close to the door of her house. The sixth was using a w.c. into which the stools of one of the first two cases were taken without disinfection. The seventh case was in a cottage which is immediately opposite to the house of one of the first two cases, and in which the accommodation was a water-closet in a small pitch-black recess in the wall of the ground-floor room; there was, moreover, no ventilation of the soil-pipe, which opened directly into the sewer into which the slops from one of the first two cases were thrown. Though the foregoing conditions were in some degree peculiar to the houses that became attacked early in the outbreak, the cases would seem, with rather better show of reason, to be attributable to the water. Thus:—The first five families which were affected between August 1st and October 6th *took the same water* (the above described Birchcliffe water); they had no relations with one another; they worked at some distance from one another; they were scattered over three contiguous streets, an adjoining square, and a square a short distance away; and the direction of their drains would not serve to explain the spread from one to another.

Six families were affected between October 6th and October 15th; these all took the Birchcliffe water, though possibly the infection in these cases may be explained by the condition of their drains and the mode of disposal of the slops and stools of those previously affected. Four families were attacked between October 15th and November 1st, none of which took the Birchcliffe water, but the first patient of one family was companion of one of the above, that of another was sister to one of the above, and visited her prior to her illness, and that of a third was using the *Bridge Lane water*, a water open to direct leakage from an old privy.

Six families were attacked between November 11th and November 23rd, four of them in one row of houses in which only one case had occurred previously. The stools of the latter were, moreover, disinfected and deposited in pails and removed. Among these cases there were five children of one family in one house all ill within a week, three working at three different mills, one at school, and one at home; evidence of a common and probably of a local cause. Each of these six families took the Birchcliffe water. There was but one patient in the next family. Here the Local Board water was used, but the patient had had dealings with a previously affected family. Then a family using the Birchcliffe water fell ill. The four succeeding families affected were about a mile away, and in some the disease is attributable to local causes. The next family was using the Local Board water. Then one of a family using the Bridge Lane water fell ill, and the next case, the last for the year 1884, was using water open to sewage contamination.

Therefore, of the first 21 tenements affected there were but four in which the Birchcliffe water was not used, viz., in order of attack, the 12th, 13th, 14th, and 15th, and in two of these four there was exposure to the local conditions of previously infected houses. The patient in the 22nd tenement did not use the Birchcliffe water, but had been in relations with the people of an infected house; and the patient in the 23rd tenement did use the Birchcliffe water.

The incidence of fever upon houses on the Birchcliffe system has now to be compared with its incidence on houses using the Local Board's water. The former number 135, and during the epidemic period 20 of them were invaded; the latter are 473 in number and, at the outside, three of them were invaded during the same period.

Then as to the portion of the Birchcliffe system most concerned in the distribution of the fever: 70 of the 135 houses derive their supply from the White Lion cistern; of these 70, only one house was invaded: 65 receive their supply from other cisterns; and fever appeared in 19 out of these 65.

The evidence seems therefore to point strongly to water pollution as essentially the means of spread of the fever. The specific pollution must have principally affected some one or two Birchcliffe cisterns. I am not prepared to say whence this pollution was originally derived; but it is noteworthy in this connexion, that during the last two weeks of June 1884 the water from the Birchcliffe springs was directed into another course to allow of haymaking on the fields over which the water naturally flows, and the higher cisterns became almost empty; it was turned again into its natural channels early in July, and the cisterns filled in the course of three or four days. The rainfall at Todmorden in June was 1.1 inch, that of July was 4.99 inches. The fields therefore in June were dry. In July they were inundated with the spring water (now re-directed

into its customary channels), with a large fall of rain and soakage from the filth deposits lying in and on the hill above. It is probable, in the light of what has been said, that at this time an infectious agent was washed into certain cisterns to give rise to the outbreak of typhoid fever, which commenced in the early days of August.

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February 23rd, 1885.
